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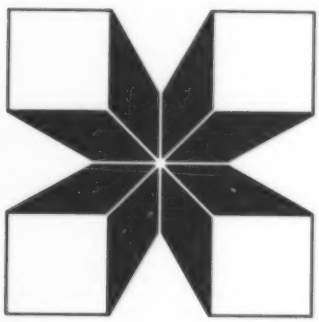

CANADA

HOUSEHOLD ENERGY SURVEYS IN THIRD WORLD CITIES

SOME METHODOLOGICAL ISSUES

STEPHEN TYLER

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SOME METHODOLOGICAL ISSUES

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HOUSEHOLD ENERGY SURVEYS IN THIRD WORLD CITIES:

SOME METHODOLOGICAL ISSUES[1]

1. Introduction

The rapid increase in demand for electricity and fuels in third World cities poses significant economic, environmental and social issues for metropolitan and national government authorities. There has been a good deal of international exhortation of measures which would increase the efficiency of energy utilization (World Bank, 1983; Goldemberg, et. al., 1988). But good policy decisions require a good understanding of the utilization of various modern and traditional fuels and the factors influencing these. The household sector in Third World cities can play an unexpectedly large role in national energy issues (Leitmann, 1989). But because it is composed of a large number of independent decision-makers living within a wide range of cultural and socio-economic contexts, it is particularly difficult to analyze without accurate local data.

Reliable data on household energy utilization in rapidly-urbanizing developing countries are seldom readily available. But these data would be valuable to urban planners and energy policy analysts, to utility companies and others concerned with provision of urban infrastructure, to fuel suppliers, as well as to public health, resource management and environmental authorities. Accurate data about fuel used, costs, sources,

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[1] The author is indebted to Josef Leitmann, Household Energy Unit, Industry and Energy Department, World Bank for a number of valuable insights. Helpful comments on a previous draft of this paper were also received from S. D. Pardesi, Systems Research Institute, Pune, India.

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appliances and consumer behaviour require field surveys of urban households.

Three types of methodological considerations are crucial in household energy surveys:

1. good social science methodology and statistical requirements for data validity (i.e. good general survey methods);

2. technical and behavioral issues specific to household energy utilization; and

3. the particular difficulties of conducting surveys in culturally-diverse urban areas in developing countries.

In order to obtain valuable results from the survey, appropriate weight must be given to each different methodological element. A careful and rigorous sampling procedure, for example, takes time and effort to complete properly, but if respondents are not able to give precise replies to poor survey questions, then the effort of sampling will be lost. Similarly, even if survey interviewers are very well-trained in interview techniques, if the sample is not selected so as to be representative of the population, then valid population parameters cannot be generated from the survey data.

This paper reviews the principal issues in each of these three categories by outlining requirements at each stage of the survey research effort. The discussion begins with the identification of data needs, and includes survey sampling, data collection issues and questionnaire design, interview procedures and interviewer training, and concludes with a brief discussion of data coding, cleaning and analysis.

There is already a good deal of energy survey work which has been carried out in many developing countries. Interest is expanding beyond a narrow group of academic researchers and

consultants to government ministries, utility firms and non-governemental organizations, each of whom have clear policy interests in energy planning. This paper is directed to these groups. It is intended to improve the quality and reliability of the growing volume of data generated in household energy surveys.

Difficult policy issues will never be resolved by better data alone, but it is the author's hope that by helping to reduce the scope for confusion and error in the data itself, this paper may contribute to a more informed debate about the assumptions and values which underlie policy choices.

The emphasis in this paper is on the particular difficulties of gathering household energy use information, but researchers conducting other types of household surveys, particularly with policy objectives in mind, will find much of this material closely analogous or directly relevant to their own situation.

2. Research objectives and survey methods

A questionnaire-based survey alone does not provide the researcher with an understanding of the phenomena under investigation. Rather, the questionnaire results provide "the empirical contours of a previously formed picture" (Desai, 1985). The outlines of this picture are based on a familiarity with real field situations derived from experience, coupled with an appreciation of explanatory models and theories which inform and enlighten these observations of the world around us.

The choice of data collection methods, sampling procedures, analytical techniques and, of course, specific survey questions all depend on the purposes of the research. In particular, it is important to distinguish between research objectives designed to further the goals of scientific inquiry and those specifically intended to illuminate policy choices for decision-makers. It is not always true that the most interesting questions from the standpoint of theoretical elegance or of extending scientific knowledge are also the most relevant to those responsible for analyzing public policy decisions.

For this reason, survey design should start by clarifying those aspects of household energy utilization which pose particular scientific or policy problems. The existing international literature and the experience from previous household energy surveys which may exist in each country are directly relevant. Fuel market studies or supply system assessments by fuel suppliers, governments or multilateral agencies may be of considerable assistance in highlighting policy issues to be considered in survey design.

The development of a policy data base is often a key reason for the effort and expense of household energy data collection. Policy-oriented research needs to begin with a consideration of who specifically will need to use the results of the survey.

What is the scope of policy action conceivable? What questions do decision-makers need answers to? Often a single, well-focussed question can yield very helpful information for policy makers.

In addition to the content of the survey questionnaire and the choice of analytical tools, policy considerations will also play a role in determining the scale of the survey. Precise estimates of the values of key variables mean increasing the size, cost and duration of the survey. In a flexible policy environment, where analytical effort and time are at a premium, the ability to broadly evaluate a range of anticipated and unanticipated issues may be more valuable than extremely precise measures of indicators which may ulimately prove to be uninteresting. Of course, the opposite also holds: in a rigid policy environment with a few, well-understood alternatives, and where inaccurate estimation will be very costly, precise estimates may be required.

Timeliness is a particular concern with policy-oriented research. In the rapidly-changing circumstances of many Third World cities, long delays in the coding, computer entry and analysis of data may render conclusions largely irrelevant for practical purposes. Policy decisions will often be made whether or not the data is neatly analyzed and the final reports completed. Researchers should be aware of the time-sensitivity of the questions they are proposing to study, and of the scheduling of budgets, project decisions, or programming choices which the results of the survey could conceivably influence.

If policy issues are those which are to be emphasized, then consultation with responsible and knowledgeable policy officials in each country will be an essential element of this phase of the work. In particular, those officials who are most likely to be able to use the results of the survey should be involved in discussions of anticipated and useful data and how these could best be obtained.

If the theoretical and scientific aspects are to be emphasized, then careful attention must be paid to the construction and criticism of competing explanatory models in order to focus on contradictions or weaknesses which might be amenable to testing by survey data.

It is quite possible to set both scientific and policy objectives for the research effort, but in that case it must be recognized that both of these preparatory steps are prerequisites to further work. In any case, the researcher must be able to formulate detailed data requirements by reflecting on what she expects to be able to say at the end of the research, and carefully considering the data which would be needed to make such statements. It might be helpful to prepare a detailed draft of the contents for a hypothetical policy brief which would contain all the essential information needed by the relevant decision-making agency, and then decide what blanks must be filled in by data collection and analysis.

Before beginning to draft a survey questionnaire, the researcher should be able to state in a single paragraph what kinds of results are anticipated, and then to list the relationships to be tested and the variables whose empirical values will be needed to undertake the tests. The type of statistical measure or test proposed in each case should be outlined in advance to ensure that the form of data collected meets the requirements of the test (e.g. ordinal vs. ratio data). In addition, variables should be identified as dependent variables for the purposes of these tests, or as independent variables. Variables needed as controls, or for tests on alternative hypotheses, should be indicated. In this fashion, survey procedures can consistently be chosen with the specific research objectives in mind to minimize the potential for sampling and non-sampling errors.

3. Sampling

The whole point of sampling is to provide reliable information about a population larger than the one actually surveyed without the cost and effort of a complete census (which is in most cases impossible anyway). The details of sampling design directly influence the precision of sample estimates for population parameters. The objective, of course, is to minimize sampling error, subject to reasonable constraints on cost and time which will vary with individual survey situations. In particular, probability sampling (each individual in the sample has a known probability of selection) must be used in order to be able to use statistical tests and to provide a scientific basis for making inferences about population parameters from the survey data (Kish, 1965).

Sampling is normally constrained by time and budget. It is therefore important to review proposed sampling procedures critically and carefully in order to assure that available resources are being used most effectively, relative to the anticipated accuracy of the results. For example, stratification of the sample in terms of a particular variable (e.g. income) can greatly reduce the overall variance of sample estimates (for a given sample size), if the number of strata is not too large. But stratification also reduces the number of cases in a particular sample stratum, which increases the variance of estimates derived for that stratum alone. Care must be taken to assess the net implications of any particular sampling scheme well in advance.

Where a reliable sampling frame (i.e. a list of all households in the city or district to be surveyed) already exists and can be demonstrated to meet the specific requirements of the survey, then the simplest procedure is to select the survey sample from this frame using simple or systematic random

sampling. Many countries have a well-developed and maintained national household sampling frame which can be used for these purposes.

It may even be possible to combine the energy survey sampling (and possibly the questionnaire surveys themselves) with other household surveys being undertaken over the same time frame, such as a national household expenditure survey. Researchers should be alert to the possibilities of saving time and expense through cooperative survey ventures of this sort, but also careful to ensure that the conduct of the survey will be compatible with household energy data collection objectives. Questions about the training of interviewers, the context of survey questions, and the timing of interviews would all need to be satisfactorily resolved.

Care must be taken in all cases to determine how the sampling frame was compiled in order to assess whether it is recent enough[2] to serve for energy survey purposes and whether its definition of the population coincides with the definition intended in the research (e.g. a sampling frame defined on the basis of property tax rolls would ignore households without formal property ownership and hence introduce systematic bias into survey results).

In the case of sampling urban households without a sampling frame, or for sampling certain sub-groups of urban households which may not be formally recognized in an existing sampling frame, a typical approach is to use an area probability sampling method. Here again, however, some existing data is crucial. The entire area to be surveyed (e.g. a city) is divided into distinct geographical zones (e.g. existing census tracts). All zones must be given some chance of selection. If the number of households within each zone is known (or estimated) in advance, such as from

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[2] However, sampling problems have been reported when attempting to use static national sampling frames in urban environments with highly mobile and rapidly changing populations in Kenya (Singh, 1980).

a recent census or survey using these boundaries, then the zones should be sampled according to their size, using a multi-stage technique. First, a zone to be sampled is chosen, and then a sample of households from within the zone is selected. The second stage of this selection may proceed on a completely random basis in the field (such as "random walk" or selection of every "nth" unit), or, to save money in surveying, on a clustered basis (cluster sampling will increase sample error, however). Final samples in each zone should be approximately the same size, but selecting the sample zones on the basis of size will maintain a constant probability of selection for households across all zones (Fowler, 1984).

Stratification of the sample is desirable if certain characteristics of interest are distributed more homogeneously within an identifiable sub-group of the population. For example, if energy use is the characteristic of interest, obvious criteria for stratification are household income (in different income groups fuel type, appliances and overall energy use are likely to be more homogeneous than across the entire population), number of people in the household, and possibly house type or physical size. In addition, regional or climatic factors should be accounted for by specific seasonal or geographical stratification. Stratification improves the precision of the sample (i.e. reduces sampling error) for those variables which are more homogeneous in the selected strata than in the population as a whole, but in small samples there is a limit to the amount of stratification which can be done before strata sizes become too small to yield results which can be confidently extrapolated to a larger population.

Thus, a crucial criterion in establishing suitable sample size is the smallest acceptable sample of some important sub-group of the total population to be sampled. For example, if it is deemed important to the survey results to be able to have good estimates of energy consumption and other characteristics of households having refrigerators and air conditioners, but these

households represent only a small group in the total population, then the sampling plan would have to address how an adequate number of this group could be included in the sample. Either the sample would have to be large, or some type of stratification and deliberate over-representation (with subsequent data weighting) would be needed.

Confidence tables for sample sizes are shown in standard statistical tables. For characteristics which are present in near 50 percent of the sample, for example, estimation of population parameters can be no more precise than +/- 17 percent once the sample (stratum) size drops below 35. Thus for small samples in particular, sampling error (which is determined by the sampling scheme type and size) is likely to dominate the survey error.

An approximation of sample size can be derived if the researcher determines a desirable sampling error limit for a typical sampled characteristic, and takes the conservative position, a priori, that approximately 50 percent of the population exhibit the characteristic in question. A formula for minimum sample size within each stratum would then be:

$$n = \frac{pq\,N}{(e/2)^2\,(N-1) + pq}$$

where n = sample size
p = probability of occurence of characteristic (say 0.5)
q = 1 - p
N = population size
e = 95% confidence interval sampling error selected by researcher

However, because sampling error may well vary for different characteristics being estimated (due to different weighting factors caused by the nature of the sampling and respondent

selection procedure) the relationship of sampling error, sample size and sample design is especially problematic. This is one argument for involvement of statistical specialists at the stage of sample design and error estimation (Kish, 1965).

In some cases, it may be possible to conduct repeat surveying of areas subject to a previous energy survey. The advantages of establishing longitudinal data mean that in areas where a previous survey was undertaken, questions from the earlier survey should be added to the new survey instrument. Not all questions will need to be repeated, and additional new questions are desirable to ensure compatibility with other areas receiving only the new survey. Care should be exercised in assessing the characteristics of households in the area to distinguish whether changing socio-economic features are due to the changed circumstances of the same households as were in the community previously, or due to substantial migration, as the conclusions about energy use trends would be different in each case.

A special sampling definition problem arises in attempting to match electricity consumption data to households. If electricity consumption is an important element of household energy use, it would be advisable to cooperate closely with electricity suppliers in order to assure access to consumer account information. In fact, it may well be discovered that the most effective way of gaining electricity consumption data which matches households identified for surveys is to select households for the survey from the electricity supplier's list of customer accounts (Januzzi, 1987). This technique could be supplemented by other sampling techniques designed to uncover non-electrified households in the field. If this approach is adopted, careful attention should be paid to the pitfalls outlined below regarding the definition of electricity customers, illegal re-sales and multiple metering.

A relevant feature of energy use is its seasonal character. This may be related to seasonal variation in energy needs (space

heating), or to variation in fuel availability (in some cities, biomass fuel availability fluctuates with the season), or to variation in the pattern of fuel use (e.g. different cooking practices depending on seasonal foods or monsoon conditions). Thus one element of the stratification of sampling for household energy use surveys is to identify likely seasonal effects and ensure sample representation from different seasons. In order to avoid introducing extraneous sources of variation, it is preferable to use sample households as their own controls by repeat sampling of the same households in different seasons.

4. Household energy data collection

The definition of a household for sampling and data collection purposes is not always straightforward. The importance of the household as an economic and statistical unit is underscored by its role, not only as the fundamental unit of social identity and cohesion, but also as the most important unit of consumption and, often, production as well. The United Nations recommends two distinct definitions of household: the housekeeping concept and the family concept (Wahab, 1980). The former concept recognizes either a one-person or multi-person household, where the household is defined both by domicile and by joint provision for food and essentials of living (in the multi-person case). Household members need not be related, and may include boarders as well as live-in domestic servants. The family concept of household, on the other hand is distinguished by the blood relations of all members, or of their relation by marriage or adoption. The former definition may be more appropriate in less developed countries in which there is more likely to be income pooling within multi-person households not composed of close relatives (Wahab, 1980).

On the other hand, operational definitions may vary in practice depending on national socio-economic conditions and survey purpose. In its household energy surveys, for which cooking energy is typically a crucial subject of investigation, the World Bank defines a household as a group of individuals who prepare and eat meals together under the same roof.[3]

Some researchers have discovered that variations in household energy use are directly related to the household's kinship role in relation to other households (A. E. Behrens, 1986). In Rio de Janeiro, a pattern of household relationships

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[3] J. Leitmann, Household Energy Unit, Industry and Energy Department, World Bank, pers. com. October, 1988.

in squatter settlements was found whereby one household provided energy-intensive services (food preparation, food storage, entertainment) for other, typically nearby, households to which members were linked by kinship. As a result these service-providing households (labelled "mother" households by Behrens) had energy consumption levels at the high end of the sample range, even if their income levels were not high. In addition, the high energy consumption of these "mother" households was also correlated directly to very low energy consumption in their linked "daughter" households. In fact, closer investigation showed that the households were in fact linked by the exchange of services, thus forming an integrated economic unit, if not an integrated physical unit.

The conclusion of Behrens' investigation was that energy surveys which relied on the physical definition of households in separate dwellings may lead to misleading conclusions about the variability of energy use. It could be clearly shown in her sample that an important reason for variations in energy use between units defined as separate households in the survey was the fact that they operated in many respects as a common unit, with most of their shared energy use being absorbed by one household (usually in exchange for other services offered by the other household). This type of definitional issue is directly relevant to the sampling procedure selected and to the questions posed to respondents in the survey, but it is difficult to generalize. Cultural features, such as independent polygamous households, will play an important role in suggesting appropriate local definitions, but investigators should be prepared to deal with anomalies which may be encountered in the field.

Another definitional issue is that of household size. The number of people in a household is obviously related to the amount of energy used, but the relationship depends on how the people are counted. Recognizing that the energy intensity of an individual's household activities (e.g. amount of cooked food eaten, amount of laundry) may be related to age, some researchers

have adopted a convention of identifying household size by adult-equivalents, or adult-meal equivalents, in addition to simply counting the number of household members (Behrens, 1986). The choice of measure here will have an important influence on the weighting of some household survey responses later on, as well as on the calculation of energy intensity figures.

A common source of data for verification of household commercial energy use and provision of supplementary information is the electricity supplier. It is typical to have at least one category of customer which corresponds to a typical residential service, and if the area being surveyed is supplied with electricity, then the utility should have access to useful historical information such as trends in unit electricity sales, aggregate load shape (possibly useful in matching with appliance utilization data), as well as verifying data for individual survey respondents through specific electricity account files.

There are some caveats to using electric utility data, however. Electricity distributors identify customers by meters, not by households. While in some cases of informal settlements the existence of a legal electricity meter identified by a unique account number for each specific household serves an important legitimizing function for the resident's property claims (Behrens, 1986), it is also possible that more than one household is served by a single electricity meter (e.g. through illegal or quasi-legal re-sales). In such cases it will be difficult to separate the consumption of different households. It is also possible that substantial amounts of electricity are "stolen" directly from distribution lines without the benefit of safe and authorized connections. Estimation of these amounts poses special problems, and must be done in the field on the basis of observations of equipment size and use. But even if the match between number of households and number of electricity meters is close within the survey area, the uncritical adoption of utility or fuel supplier data may well overstate the consumption of commercial fuels for domestic purposes.

This is because of the frequency of commercial activities in urban households, where several common informal sector businesses such as preparation of foods for street markets or taking in laundry, which are energy-intensive in nature, are normally operated from the home (Thurston, 1985; Tinker, 1987a). Therefore, a fundamental analytical decision which must be addressed before designing a questionnaire is how to distinguish energy consumption for strictly domestic purposes from energy used essentially for business purposes within the household. If such uses cannot be distinguished in practice on the basis of available data, then the variance of domestic energy utilization obviously increases substantially and the predictive power of survey data may be greatly weakened. One solution might be to distinguish households in which energy-intensive businesses were operating and analyze their energy consumption as a separate class.

Depending on local circumstances, another potential difficulty in data collection may relate to the information about the acquisition of fuels in informal markets. In some cities, formal fuel markets which are subject to direct government control and taxation may be strained from time to time by fuel shortages or quotas. Very often, informal markets can still provide fuels, but at much different prices (and perhaps quality as well). Such transactions may be quasi-legal or strictly illegal for the parties involved (particularly if taxes are avoided). Similarly, if peri-urban forests are subject to large-scale non-licensed firewood extraction, then many city wood or charcoal purchasers will be aware of the source of their fuel and its quasi-legal status. Under these conditions, accurate price and source information may be difficult to obtain from questionnaire respondents and may have to be supplemented by direct local field investigations.

This is analogous to the well-known problems of acquiring accurate income data in household surveys. The difficulties of obtaining income data are directly relevant here because of the

theoretical and practical importance of the linkages between household income and energy use. Yet income is extremely difficult to measure accurately, both because the definition of income is problematic in an economy in which non-cash transactions play an important role, and because many households wish to deliberately withold income data to protect themselves from taxation or other legal liabilities. Household income should properly include not only cash income through self-employment, occasional employment or wages, but also transfer payments to the household from the state, remittances from family members elsewhere, and imputed rents (e.g. the difference between the market value of the household dwelling and what it actually costs them). It is often preferable, therefore, to adopt proxy measures for household income (such as house area, the number of furnishings or appliances, etc.).

There are alternative data collection methods besides administration of an interview questionnaire. These might include, for example, maintaining regular diaries (e.g. on fuel or appliance use, or purchases), or even self-completion of a written questionnaire. These have the advantages, if conducted over a period of time, of enabling respondents to record activity and energy use as it takes place, thereby reducing errors associated with inaccurate memory during questionnaire interviews. They also require less direct effort and expense in the form of interviewer time. However, they place a heavy emphasis on the language capabilities and the motivation of the respondent. These factors are typically correlated with important household characteristics such as income and education, or with the household's inherent interest in the survey subjects, and so the results are likely to be biased due to sample attrition. The choice of sampling technique will also be closely related to data collection method: area probability sampling lends itself most readily to personal interviews.

Sample results may include large errors if some proportion of respondents are unwilling or unable to answer certain portions

of the questionnaire. Non-response error could arise, for example, due to illness, limitations of linguistic comprehension, migration or simply due to absence from the residence. Serious bias of results is introduced if the characteristics of the non-respondents differ in a systematic way from those of respondents. This can be one of the largest sources of error in surveys (Fowler, 1984). Survey designs must therefore address specific measures to ensure a high response rate. Efforts should be made to undertake repeat visits for interviews if respondents cannot be located on the first visit, or to have a standby list of randomly-selected substitutes for such an eventuality, in order to reduce this bias. It is also important to properly train interviewers to present the survey in a positive light and provide sensitive encouragement to reluctant interview subjects. The potential for non-sample error of this type can also be reduced through careful questionnaire design.

Other data collection issues which should be considered before proceeding to questionnaire design include factors specific to the nature of energy use in the home. One issue is the allocation of fuel consumption by type of use when multiple purposes are involved. A typical example is the use of charcoal during winter months for combined space heating and cooking purposes. It may not be possible to determine whether household charcoal consumption is being used primarily for space heating or cooking purposes during the heating season. A useful convention is to compare the monthly consumption of the fuel during the peak heating season and during the summer months. If winter consumption is less than or equal to summer consumption then the entire amount should be allocated to cooking uses, while if winter consumption is higher, the difference can be assigned to space heating (see for example Amous and Ouerghi, 1986).

Another difficult situation when categorizing energy use by type is that energy use sometimes serves a purpose somewhat less obvious than it would first seem. For example, in North Africa it is an important and common social function for men to get

together for afternoon tea and conversation, which can last several hours. The tea is specially brewed and kept hot on an open charcoal fire, usually outdoors. The unique burning characteristics of charcoal ensure that the tea is heated at a slow and even rate, and then kept hot over a long period of time without the need for attention. While the obvious purpose of using the charcoal can be stated as "making tea", this description fails to capture the particular social context of the situation, and the way in which this limits the potential for significant fuel substition.

Another factor which can complicate the identification of fuel use is the prevailing conventions and expectations about household activities. Some possible fuel uses are not widely recognized or anticipated and hence can be missed in surveys. For example, in Tunisia, the traditional bread can only be prepared by baking on the inside surface of a domed clay oven (tabouna). The tabouna can accept a wide variety of biomass fuels from wood to twigs to agricultural wastes. It is still widely used in rural areas, but in urban areas almost all residents purchase commercially baked bread. Utility company researchers completely ignored the possibility of tabouna use in urban areas in their energy use survey, and did not include any questions which would enable respondents to report its use for baking traditional bread, the type or amount of fuel used (STEG, 1985). On the other hand, an independent survey undertaken at about the same time discovered significant urban use of the tabouna, among electrified and non-electrified households, and was able to estimate biomass fuel used specifically for baking bread (Amous and Ouerghi, 1986). In order to detect and overcome such potential biases, it is important to undertake preliminary investigations from a critical perspective, conduct careful pre-tests of draft questionnaires, and leave opportunities for flexible responses in survey design (e.g. "other" categories).

Collection of appliance energy use data also poses special problems. Identifying the actual consumption of electric

appliances under normal operating conditions demands measurement of appliance current over time and then estimates of actual hours of use. Nameplate power ratings are not good guides to actual operating conditions: they tend to overstate normal power consumption in many cases.

The best way to obtain accurate data about use of appliances and about the energy-consuming activities of household members is through measurement. Alternatively, some type of diary or time budget survey may be used over a period of several weeks. Respondents' memories are often inaccurate with respect to time use questions and the use of some appliances, such as television, may be highly variable. Unfortunately, diary techniques tend to introduce bias into the results unless very carefully designed so as to be simple, and unless incentives are provided to reduce respondent attrition over the survey period. A better, but usually more expensive technique, is to install measuring and recording equipment on major appliances which can detect periods of use and volume of current drawn. A useful compromise might be to test a small number of appliances under realistic laboratory or household conditions to measure actual performance, and use these results to generalize to the population.

One factor in assessing the possibility of using alternative fuels in the household is the form in which fuels are locally available in relation to household income and expenditure patterns and storage space. Fuel purchasing decisions may be related not only to fuel price and household income, but also to such issues as fuel storage capacity and the ease of transporting fuels to the home. Another relevant issue is the cost and local availability of different types of energy-using appliances (stoves, refrigerators, lights, etc.). Policy analysis requires information on the durability of appliances, their maintenance and repair costs and expected useful lifetime (e.g. for life cycle costing). Therefore information on the appliance and fuel distribution and marketing system is an important adjunct to

household survey data in order to be able to interpret household behavior.

5. Questionnaire design

It should be emphasized that the role of the questionnaire is only to provide empirical verification of hypotheses which have already been formulated and appear to have some basis in observed phenomena.

The collection of quantitative data will require the use of a structured and standardized questionnaire, although not all questions need be asked of each respondent. Proper formulation of questions and design of the entire questionnaire will ensure that the questions actually measure the characteristics intended. Good questions should be reliable, meaning that similar answers will be obtained from different respondents in similar situations, and valid, meaning that the answers correspond closely to what they are intended to measure.

To assure reliability of the questionnaire, all interviewer questions, instructions and comments should be carefully scripted and repeated exactly the same to each respondent. In all cases, care should be taken to use appropriate local languages and idioms. Questions must be clear and unambiguous, so that they mean the same thing to every respondent. If vague terms must be used, then these should be carefully defined. Often, in the explanation offered by the interviewer, it will be useful to give an example of the form of response which is being requested.

For example, a question like "Do you use kerosene for cooking or lighting?" should be simplified into several separate questions. It would be preferable to clarify what is meant by "cooking", and over what time period the question applies. A better question might be "In the last week, have you used kerosene for preparing the evening meal?" Alternatively, the interviewer could preface a question by a brief explanation: "For the next series of questions, I would like you to think about how you prepared all the meals that your family has eaten

over the past week. Have you used any kerosene fuel to cook all or part of any meal within the last week?" Note that the specific wording of the question will depend on the exact information which is being sought. But without a clear idea of the information needed and a clear question to obtain it, results will not be useful.

It is especially difficult to prepare reliable questions on issues of causality. Asking respondents why they make certain choices or behave in certain ways may reveal some unexpected answers, but is unlikely to yield comparable and reliable results without very careful preparation. Different respondents have completely different notions of causality and rational behavior is culturally relative. Because responses will differ with the respondent's frame of reference, questions either have to explore for causation indirectly (by setting up hypothetical situations and asking for responses), or have to clearly define a frame of reference for the question (e.g. by limiting choice of response "Which of the following characteristics is most important in your choice of kerosene as a cooking fuel:.....").

This raises the issue of open versus closed questions. Closed questions (where the respondent must select from a constrained list of alternatives) are more reliable and give more useful data from an analytical standpoint because this form of question increases the likelihood that the frequency of any given response will be high enough for statistical manipulations. However, it is undoubtedly more satisfying for the respondent to be able to select his or her own response, and an open response offers the prospect of unanticipated factors being raised. For the benefit of both respondent and surveyor, it is advisable to have at least some open questions which allow the respondent the opportunity to provide feedback on the questionnaire or related issues (Leitmann, 1988).

It is very common for questionnaires to be administered in the company of other household members. This implies that responses may be conditioned on what other household members

expect to hear. But it also gives the opportunity to improve the validity of the question by ensuring that the member of the household who knows most about the subject can answer the question (depending on the cultural norms of who is expected to speak for which type of household issue). Indeed, different sections of a questionnaire may best be answered by different household members. Here it is vital to have an appreciation of the roles of different household members in relation to fuel provision and use in order to target questions appropriately (Tinker, 1987b). For example, if women do most of the cooking, then questions on cooking fuel consumption and appliance use should be directed to them. On the other hand, if men most often buy the fuel, then questions about the frequency and amounts of fuel purchases are best put to them. There should be a simple way for surveyors to indicate on their response forms which member of the household provided information for each question.

Another way to improve the validity of key questions is to include tests for the consistency of responses to similar questions spread throughout the questionnaire. Questions which are rephrased and repeated permit the interviewer to narrow down the range of uncertainty about inconsistent responses (see Desai, 1985; Behrens, 1986).

In designing individual questions, the following points should be used as a guide:[4]

1. Is this a question that can be asked exactly the way it is written?
2. Is this a question that will mean the same thing to everyone?
3. Is this a question that people can answer?
4. Is this a question that people will be willing to answer, given the data collection procedures to be used?

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[4] from Fowler (1984), p. 101.

These points should also be considered when the questionnaire is tested. A test should be undertaken under the same conditions as anticipated for the survey, but for a much smaller sample (10-40 households only). For interview surveys, it would be useful to tape record survey interviews for later analysis to help spot respondent confusion or ambiguous questions. Data from the test survey should be used to set up the anticipated statistical tests and check for their consistency and sensibility in light of likely data constraints.

It is also possible to use repeat surveying of the same test sample to isolate the sources and magnitudes of non-sampling error (Grootaert, et.al., 1980). Non-sampling error can be due to respondent bias, memory lapse, or lack of knowledge, as well as to enumerator error. An interesting finding in the case of the Hong Kong household surveys reported on by Grootaert et. al. was that enumerator errors actually increased with greater interviewer experience (possibly due to declining attention as they became more familiar with the survey). Corrective measures in the design, supervision and administration of the survey can reduce each of these types of error if they are discovered.

The role of physical measurements in surveys should be given consideration (see the discussion of appliance metering above). While questionnaires are essential for obtaining qualitative information, much quantitative data can be collected directly by measurement (e.g. wood volumes, air quality, lighting intensity, appliance size and metered energy use). Such values are obviously more accurate than relying on respondent estimates for quantitative data. They are particularly helpful in verifying conversion factors from local measurement units (volume, weight, length) to standard units, as official conversions may not match actual practice.

It is always advisable, if working outside the context of one's own region, to consult with those familiar with the local or regional culture prior to designing the survey instrument. It is particularly helpful to identify local cuisine and the demands

this places on cooking practices, to review other specific features of household life, and to incorporate any linguistic changes or idioms to avoid confusion in interpreting questions. An obvious element of local variation might be units of measurement. In the case of firewood, for example, depending on the location it may be sold by the truckload, or by camel load, by bundle or by weight. Knowledge of the most common local units permits more appropriate wording of questions and facilitates scaling and comparisons of responses.

The questionnaire should include items designed to capture the respondent's attention by dealing with matters of self-interest or on which strong opinions are likely to be held at an early stage. The length of an interview questionnaire may depend on the culture. U.S. guidelines suggest interviews should be kept below one-half hour (Fowler, 1984), and a review of rural energy survey practices recommends they should not exceed 45 minutes at most (Desai, 1985): otherwise the respondent is likely to grow impatient and uncooperative. Because of the importance of keeping the survey short, critical editing and the elimination of irrelevant questions are crucial steps in questionnaire preparation.

For further discussion of questionnaire design suggestions specifically for household energy surveys, reference should be made to a useful World Bank paper on the subject (Leitmann, 1988).

6. Questionnaire implementation

The most important aspects of administering the questionnaire are the selection and training of interviewers. The quality of the information collected depends crucially on their ability to enlist the cooperation of respondents, to motivate respondents to answer accurately, and then to properly record responses.

Qualifications of interviewers may vary widely, but it is generally agreed that they should be well educated and perceptive, with a strong ability to communicate in a confident, positive and assertive, but responsive, fashion with subject household members (Fowler, 1984). Substantive knowledge of the field under investigation (i.e. household energy use) may be more of a liability than an asset, as it could bring with it preconceptions about the subject which cloud the interviewer's ability to properly present and record information.

Interviewers must be trained in the purposes of the survey, and the nature of the sampling process. Techniques for handling a variety of interview situations, properly explaining and posing questions, non-directive probing and recording responses on appropriate coding sheets should be thoroughly reviewed. Interviewers should know how to handle anticipated problems in the field. Novices should have the opportunity to conduct survey interviews in the company of experienced interviewers in the field in order to build confidence and practice these techniques.

It is crucial that all interviewers use the same procedures for introducing the survey and its individual questions, and for recording responses to different types of questions.

They should be familiar with the expectations of the survey leaders about field conditions, hours of work and productivity, and logistical arrangements.

Supervision of field work is a task which is concerned with ensuring that all the necessary local preparatory steps are undertaken prior to starting the survey, and then verifying results and correcting deficiencies in data collection. Public authorities must be contacted, the sample must be verified and interviewers assisted in locating households, and logistical details such as transportation and lodging for interviewers must all be addressed. The survey supervisors are also normally responsible for verifying that all parts of a questionnaire are properly completed and for undertaking selected verification of survey responses (usually involving partial or complete re-surveys of some proportion of the initial sample).

A number of cultural factors which can affect the characteristics of survey sampling and questionnaire design have already been mentioned. A problem which surveyors must be sensitive to in conducting questionnaire interviews is the respondents' perceptions of the interviewer's role, status and authority. While respondents in any culture may be affected by so-called "courtesy bias" (i.e. giving the interviewer the answer they believe he wants to hear), this type of error is particularly pervasive in cultures which emphasize deference to authority and status, such as some Asian countries. The best way to avoid confusion in the mind of the respondent, and to clarify the type of response desired, is to emphasize the scientific nature of the survey and the importance of each individual's own accurate responses (Fowler, 1984), while simultaneously avoiding linking the interviewer to any explicit social or political status (Leitmann, 1988).

It is also important, of course, to follow local socially acceptable interview procedures. Thus, considerations such as cultural norms of privacy and the acceptability of different questions between persons of different gender will be important considerations (e.g. in Muslim households it may be delicate for female interviewers to question male heads of households). It may also be true that women, who typically have the bulk of

domestic responsibilities relating to energy use, are more comfortable discussing such matters with other women. For this reason, it may be preferable to use female interviewers.

7. Preparing data for analysis

After questionnaires have been checked, and a selection of results have been verified, coding of responses can proceed. This step can be simplified if coding requirements are carefully considered in advance and interviewers can encode responses as they are given. All the data must be screened for coding and response errors before analysis.

The time required for data screening and entry is usually underestimated. Allow twice as much time as you expect, and safeguard all data files by making copies to protect against accidental loss. The process of data checking is tedious, but essential to the quality of the final result. Normally, it can be done as data is entered into the computer, using the capabilities of data management software. Most of these systems permit the user to identify permissible values for each variable as well as characteristic skip patterns in responses and other questionnaire features. Editing of dubious data values must be done manually, using judgement in determining whether a value can be altered (i.e. due to a misprint or typographical error) or if it must be scrapped, and recording in each case the basis of the action taken.

Analysis and reporting of results should include enough methodological detail to enable independent assessment of the methods used or the comparison of techniques in similar studies (Fowler, 1984). In particular, survey design, sampling procedures, interviewing techniques, non-response characteristics, exact survey wording, and data cleaning procedures followed should all be made explicit. Numerical estimates of sampling error and sampling design effects for various measures surveyed should be calculated and reported. The likely influence of non-response should be indicated. Finally, assessments of the reliability and validity of the key survey measures would be helpful indications to the reader and user of survey data of the confidence which can be placed in the results.

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